MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

EMF3066 – ANTENNA AND PROPAGATION

(MCE & TE)

15th MARCH 2018
09:00 a.m. – 11:00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages with 5 Questions only.

2. Attempt **ALL FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Define the following terms related to antenna radiation pattern:

(i) 3dB beamwidth

[2 marks]

(ii) Minor lobe

[1 mark]

(b) The normalized radiation intensity of an antenna is given by:

$U = U_{max}\,[sin(\theta)cos^2(\varphi)]$ for $0 \le \theta \le \pi$ *and* $0 \le \varphi \le \frac{\pi}{2}, \frac{3\pi}{2} \le \varphi \le 2\pi$

$U = 0$ for elsewhere

Find the followings:

(i) Radiation pattern (plot of radiation intensity),

[8 marks]

(ii) Radiated power, and

[5 marks]

(iii) Maximum directivity.

[4 marks]

Question 2

(a) An array is constructed with two half-wave dipoles spaced half-wavelength apart ($d = \lambda/2$). The dipoles are arranged along the Z-axis, with the dipole oriented parallel to the X-axis, as shown in Figure Q2(a) below. The dipoles are fed with equal power and have a progressive phase shift (α) of 45° between elements.

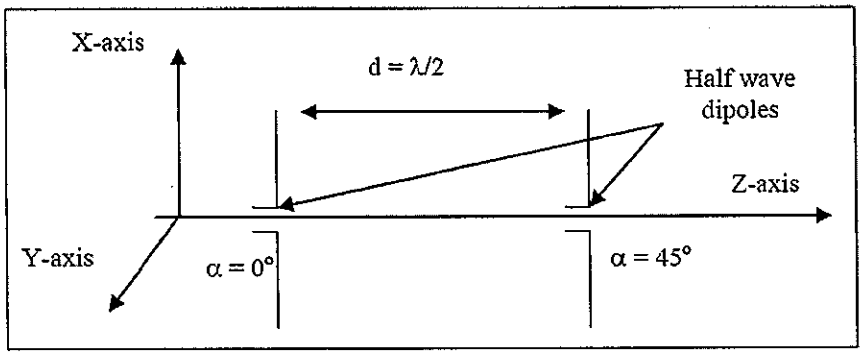

Figure Q2(a)

(i) Determine the array factor for this arrangements.

[8 marks]

(ii) Calculate the pattern maximum and pattern nulls for the E-plane of this array.

[8 marks]

Continued...

(b) Explain the effect of increasing the element number, N in an antenna array (with all the other parameters constant).

[4 marks]

Question 3

(a) Yagi-Uda and log-periodic antennas have similar appearance. However there are major differences between them in construction and application. Describe this differences with the help of diagrams.

[10 marks]

(a) Discuss the differences and similarities between microstrip patch, horn, dipole and helical antennas, in terms of their radiation pattern, gain and polarization.

[10 marks]

Question 4

(a) Explain the sky wave propagation mechanism.

[8 marks]

(b) Given that a transmitting antenna has a gain of 50 dBi and radiates a power of 15 W at a frequency of 8 GHz. Find the received power at a distance of 20 km if similar antenna is used as receiving antenna.

[5 marks]

(c) Assume that reflection takes place at a height of 400 km and the maximum density in the ionosphere corresponds to a refractive index of 0.9 at 10 MHz. Assuming that earth is flat, find the range for which Maximum Usable Frequency (MUF) is 10 MHz.

[7 marks]

Question 5

(a) With the aid of a suitable diagram, derive the Doppler frequency shift for a closing target. Explain all the terms used in the derivation.

[12 marks]

(b) C-band radar has the following parameters:
Peak transmit power, $P_t = 1.5$ MW,
Operating frequency, $f_o = 5.6$ GHz,
Antenna gain, $G = 45$ dB,
Effective temperature, $T_e = 290$ K and
Pulse width, $\tau = 0.2$ μs.

If the radar's minimum SNR is 20 dB and assuming that the target cross section, σ is 0.1 m^2 with a system loss of 3 dB, determine the maximum range.
[Note: Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K]

[8 marks]

Continued...

Appendix A

Physical Constants and Units

Constant	Symbol	Value (mks units)
Speed of light in vacuum	c	3×10^{8} m/s
Electron charge	q	1.602×10^{-19} C
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Permittivity of free space	ε_0	8.8542×10^{-12} F/m
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ N/A^2
Electron volt	eV	1 eV = 1.602×10^{-19} J
Planck's constant	h	6.626×10^{-34} J·s
Electron rest mass	m	9.11×10^{-31} kg
Effective electron mass	m_e	$0.068m$
Effective hole mass	m_h	$0.56m$

End of paper.